Portland General Electric Company:
Station "L"
1841 S.E. Water Street
Portland
Multnomah County
Oregon

HAER No. OR-12

HAER
ORE.
26-PORT,
12-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of the Interior
San Francisco, CA 94102

HAER
ORE,
26-PORT,
12-

HISTORIC AMERICAN ENGINEERING RECORD

PORTLAND GENERAL ELECTRIC COMPANY: STATION "L" HAER No. OR-12

Location: 1841 S.E. Water Street
Portland, Multnomah County, Oregon
USGS Topo Quad: Portland, Oregon-Washington;
Scale: 1:24,000
UTM Reference Points: Zone:10
Easting: 526160 Northing: 5039320

Present Owner: Oregon Museum of Science and Industry
4015 Southwest Canyon Road
Portland, Oregon 97225

Present Occupants: Vacant

Present Use: The site of the retired steam electric plant is approximately 18 acres in size, of which a 4.7 acre parcel is listed on the National Register of Historic Places. Station "L" is to be redeveloped as the new quarters for the Oregon Museum of Science and Industry. Seven of the existing structures, buildings L1, L5, L6, L8, A, C and E, will be integrated into the new OMSI facilities. The remaining 18 structures on the site will be removed. The facilities will include some 200,000 square feet of exhibit space, classrooms, an Omnimax theatre, a planetarium, offices, support space, food service and a retail shop.

Significance: Station "L" is primarily a group of six structures designed and built by the Portland General Electric Company between 1910 and 1929. The Station represents the growth and the use of Portland General Electric Company's thermal generation power plants; of PGE's thermal plants, Station "L" delivered service for the longest continuous time. Station "L" is important for its link with the growth of electric power in Portland.

The Station "L" site is also significant because of its association with Portland pioneer James Stephens for the site's association with early railroad development.

Report Prepared by: Christopher F. David
Heritage Investment Corporation
123 Northwest Second Avenue
Portland, Oregon 97209

Date: April 20, 1988

PART I. PHYSICAL SETTING OF STATION "L"

Station "L" is a group of six industrial buildings and an attached river dock, designed and constructed between 1910-1929 by the Portland General Electric Company. The site is located on the east bank of the Willamette River between the Hawthorne and Ross Island Bridges, just south of the Marquam Bridge ramp. The brick and concrete buildings which make up the ensemble are all one or two stories in height and are used to house the various generating equipment of the Portland General Electric Company. The overall condition of the buildings is good except for the 1924 boiler room addition. The dock is in fair to poor condition.

The entire Station "L" site (HAER No. OR-12-24) covers an area of approximately 15 acres, delineated by the Willamette River on the west, Southeast Clay Street on the north, the tracks of the Southern Pacific Railroad on the east, and Southeast Caruthers street on the south. The east ramp of the Marquam Bridge passes overhead on the western boundary of the site, and several of the bridge piers are located in the northwest corner of the property. The site is flat and lies approximately twenty feet above the river. It is devoid of trees and shrubs, with the exception of some natural vegetation growing along the river's edge, consisting primarily of blackberries, willow and poplar. More than twenty-five structures of varying age, materials and use are distributed across the site. Dates of construction range form approximately 1906 to 1975 and the condition of the structures varies.

The primary group of historic buildings on the Station "L" property are collectively entitled the Station "L" Ensemble and are clustered on the riverbank just south of the Marquam Bridge ramp on Block A, Tax Lot 23, Stephens Addition to the City of Portland. Five of the buildings in the ensemble are connected and include; the turbine room, LP boiler room, and the Lincoln Substation, (not to be confused with the Lincoln powerplant at the foot of S.W. Harrison Street, a Pacific Power & Light property), all built in 1910, the 1924 HP Boiler room extension, and the 1929 powerhouse extension. The sixth building to make up the ensemble is located just to the northeast of the connected buildings and is known as the Stephens Substation, built in 1929 (HAER No. OR-12-25).

The Station "L" site, while closely associated with the growth of the electric power industry in Portland and the Portland General Electric Company, is also connected with events and individuals who played significant roles in Portland's and the region's earliest settlement, development and growth.

PART II. HISTORICAL CONTEXT OF STATION "L"

James B. Stephens

The original development of the Station "L" site began 140 years ago, when James B. Stephens obtained a square mile of land on the east bank of the Willamette River, bounded roughly by present-day Southeast Market Street, Lincoln Street, Southeast Union Avenue, and the Willamette River. Stephens, a barrel maker by trade, made the overland trip to the Oregon country in 1844 with his wife and three children. After a year in Oregon City, he purchased his property for $200 from Dr. John McLoughlin, "Father of Oregon," Chief Factor for the Hudson's Bay Company and administrator of the estate of a Frenchman, whose estate included the land.

The southern edge of the property marked the beginning of a wide slough, later known as Stephens' Slough, which ran in a southeasterly direction to an area near present-day Eleventh and Taggart Streets. The slough was gradually filled in, especially after the 1890s, but in 1845 Stephens constructed a log cabin nearby and lived there with his family, making and selling barrels. He also began a ferry service, rowing passengers in a flat boat from a landing at East Oak to West Stark Street. In 1850 this boat was replaced with a larger one, on a cable propelled by horses on a treadmill. In that same year he laid out the townsite of East Portland, filing the plat map in 1861, which was the basis of the city's incorporation in 1870. Stephens also had the distinction of paying the first taxes into the Multnomah County treasury when, in 1855, he purchased his ferry operator's license for $10.

It is believed that in 1862 Stephens replaced his log cabin with a more substantial house. His new home was painted white, two stories in height and crowned with a belvedere, resting on a high brick foundation near the river's edge. It was easily seen from the west side of the river and remained a prominent feature on the east bank of the Willamette until 1902 when it was moved 12 blocks east to its present location at S.E. Twelfth and Stephens Streets. In 1978 it was designated the city's oldest house by the Portland Historical Landmarks Commission.

Stephens, known affectionately as "Uncle Jimmie" by early East Portland residents, was a generous man. He was known to have taken recent arrivals to the area into his home for weeks at a time until they could become settled. He eventually acquired almost 2,000 acres of land in East Portland, much of which he gave away or sold at low prices to newcomers. He donated seven acres for the State's first insane asylum, at Tenth and Hawthorne, as well as the property for Lone Fir Cemetery. In the early 1860s, in partnership with his son-in-law, he opened the East Portland Savings and Loan Bank. The bank eventually failed and, as a result, Stephens lost much of his land. He died in 1899, leaving a small estate.

Railway Development

In addition to its association with the early settlement of Portland, the Station "L" property carried the first railroad in the Willamette Valley. The first rails of the Oregon Central Railway (east side) were laid in place on October 26, 1869. The Oregonian reported that, "There were no ceremonies other than the firing of the cannon; the road was begun in a business way (coats off and sleeves rolled up)." The rails were delivered to a temporary dock "built near Mr. Stephens' place" on the east bank of the Willamette River.

The steamer Moses Taylor delivered the rails to the wharf. A span of track was laid from the wharf to a turntable, at which point the materials unloaded from the steamboat were put on a car which moved to the construction site. The casual ceremony was followed on October 28 by a formal dedication. Several hundred witnesses gathered once again on the east bank of the river to hear speeches by U.S. Senator George H. Williams and attorney John H. Mitchell. The honor of driving the first spike was given to J. L. Parrish, one of Oregon's early settlers who had arrived in May, 1840. The event was accompanied by music from a military band and the firing of a cannon.

In March, 1870, Ben Holladay incorporated the Oregon & California Rail Road Company and purchased the Oregon Central Railroad Companies (east and west sides). In 1876, Holladay was bought out by Henry Villard who, by May, 1884, extended the O&C lines as far south as Ashland. In July, 1887, the O&C properties were leased to the Southern Pacific Railroad Company, in whose control they have remained for 100 years.

Similar to present-day speculation occurring in connection with development of the light-rail right-of-way, land prices adjacent to the railroad tracks in East Portland began to escalate as soon as construction was announced. Despite the fact that much of the property bordering the river was annually flooded, the Oregonian commented that, "A purchaser has been offered lately almost as much for a lot as he gave (a year ago) for the block . . . ". This speculation reflected the increased population and building which was taking place in East Portland as a result of the railroad construction. In September, 1870, citizens in the area met, discussed, and adopted a city charter which established the boundaries of their new city, specified officers, their powers and responsibilities, and outlined the services to be provided to the residents of East Portland. The new city of East Portland had a population of approximately 900 people distributed over 4-1/2 square miles.

Development of Electrical Use

Similar to the 1870s when the construction of the railroad led to the growth and expansion of East Portland, the opening of the Morrison Street Bridge in 1884--the first to span the Willamette River--led to another, even greater, building boom. With the new bridge in place, the east and west sides of the river could be connected with street railway lines, which had previously operated on the separate sides of the river.

Horse-and mule-drawn streetcars first appeared in Portland in 1872. By 1888-89 the street railways began converting from horse and steam power to electricity. The electricity for this conversion was initially provided by the Willamette Falls Electric Company of Oregon City, which had been incorporated in November, 1888. In June, 1889, this company became one of the first in the country to transmit long distance electrical energy for commercial purposes by dispatching an electric current from Oregon City to Portland, a distance of 13 miles.

City residents had first become acquainted with the new energy source some ten years earlier when the steamship State of California arrived for a visit. Six incandescent light bulbs on the ship were lit by electricity produced by a small steam engine. Afterwards some local residents reproduced the effect in small, isolated experiments, but it was not until March, 1885, that Portland entered into its first contract for the illumination of city streets with electricity. The contract was awarded to the U.S. Electric Light and Power Company, which had been incorporated just one year before in 1884. That company was in turn acquired in November, 1888, by Willamette Falls Electric Company.

In March, 1890, the Willamette Falls Electric Company opened its first substation in Portland at the foot of Montgomery Street. Electricity transmitted from Oregon City was provided to the first electrified streetcar line, which ran between Portland and Fulton (near present day John's Landing). Once conversion to the new power source had begun, demands far exceeded the Willamette Falls Electric Company's ability to provide increased electricity. In order to acquire the capital necessary to expand service, the president of the Willamette Falls Electric Company, P. F. Morey, in partnership with Fred Holman and Henry Failing, formed the Portland General Electric Company in August, 1892. New capital came from outside the Portland area from financial institutions in New England. The purpose of the newly formed company was, "to engage in a general light and power business." One of PGE's first actions was to acquire the Willamette Falls Electric Company, which it accomplished on September 1, 1892.

From the 1880s through the 1890s, the Portland metropolitan area began an unprecedented period of growth. In 1891 the cities of St. Johns, East Portland and Albina were consolidated with the City

of Portland, with Sellwood and Linnton following in 1893 and 1915, respectively. Portland's population was 50,560 in 1891; by 1915 it had increased to 232,500. In the same time period the city's boundaries were expanded from just under 26 square miles to 66 square miles. By 1916, the city contained 192 miles of city streetcar lines, which extended from Sellwood to North Portland, and from Mt. Tabor to the West Hills. In addition, over 75 miles of electric inter-urban trackage extended to Estacada, Oregon City, Lake Oswego and the Tualatin Valley.

In addition to providing power for transportation needs, the businesses and residences of Portland steadily increased their demand for electricity. In order to fulfill this increasing demand for electricity PGE began building new substations and thermal generation power plants in 1892 with the infusion of capital from east coast interests. Of all the structures connected with thermal power generation which were acquired or constructed by PGE in these early years only those at Station "L" remain. PGE's 1892 purchase of the Willamette Falls Electric Company included its substation at the foot of Montgomery Street; this was designated as Station "A". Station "B", a hydro-generation plant on the west side of Oregon City was added in 1893. Station "C", PGE's first steam-generation plant, was constructed in 1901 at Front and Sherlock Streets. This Station was located to take advantage of wood fuel provided by the nearby Eastern and Western Lumber Company; the Station was dismantled in 1912. Steam Station "D", at 18th and Mill, provided power for the short-lived Portland Cable Railway Company. PGE leased this station in 1904 and abandoned it a year later.

Among the features of the Lewis and Clark Exposition in 1905 was the illumination of the pathways, parks, and the delineation of the Exposition buildings by thousands of electric light bulbs. To meet the needs of the Exposition, PGE constructed Station "E", just west of Station "C". This plant also provided power for the increased number of trolleys which traveled to the Exposition grounds. Other substations were located on Northeast Knott Street, Southwest Jefferson Street, and the Lents, Sellwood, Piedmont and Mt. Tabor neighborhoods. By 1906, PGE had expanded its holdings outside the City of Portland. The company obtained numerous independently owned and operated power companies throughout the northern Willamette Valley, including stations in Silverton, Newberg, Sheridan and Salem.

Fifteen years after its incorporation, PGE was once again unable to raise enough capital locally to finance its growth. As in 1892, east coast investors again provided assistance, but this time in exchange for a majority of the company's stock. In the midst of the economic expansion which followed the close of the Lewis and Clark Exposition, PGE, in December, 1907, became a subsidiary of a holding company, the Portland Railway Light and Power Company (PRL&PCO). This new firm controlled all city and inter-urban

railway lines, as well as most of the electric power provided to business and industry. The three subsidiary arms of PRL&P were the Portland Railway Company, which operated the city streetcar lines; the Oregon Water, Power and Electric Company, which dealt with the inter-urban car lines; and Portland General Electric, which continued to supply power for transportation, lighting and other needs. Under PRL&P, PGE continued to increase its generation of electricity with the established formula of merger, new construction, system improvement and modernization.

In 1906, prior to its merger with PRL&P Company, PGE signed an agreement to purchase any excess power produced by a small steam-powered station on the east side of the Willamette River, at the foot of Lincoln Street. Constructed in 1892, the plant provided power for the cars of the City and Suburban Railway Company, a locally established concern, which under another name was acquired by PRL&P Company in 1907. Later, in 1906, PGE assumed complete operation of the plant, now known as Station "F", and utilized the power until 1911, when the equipment in the newly-completed Station "L" came on line.

Under PRL&P's management, PGE's electrical generation increased an average of 20% per year after 1908. Construction of hydro-electric plants on the upper Clackamas River was being planned, but it was recognized that this source had to be supplemented by steam-generation plants. The company needed a supply of energy close to downtown Portland. Property adjacent to Station "F"--near the former site of the Stephens' house, in an area crisscrossed with tracks from local, inter-urban and inter-state train lines--was chosen. The site was in close proximity to the Inman-Poulsen Lumber Company, which could provide a steady supply of wood waste for the new operation. Construction of the new steam plant progressed rapidly and the first of the Station "L" buildings were completed in late 1910. On December 12, 1910 the first 2,000 KW turbine generator began operation; this was followed one month later by the installation and start up of a second 2,000 KW unit. In June, 1911, a 2,500 HP, Corliss steam engine was added. At the same time, Lincoln Substation was erected to house the high tension buss and switching equipment for Station"L". In addition, Lincoln Substation contained three transformers which received energy from the transmission line from Station "M" on the Clackamas River.

Station "L" and the Inman-Poulsen Mill completed a mutually beneficial agreement: the mill would supply the fuel needs of the steam-generation plant, and in turn, Station "L" would provide the mill with the electricity for its operation. Although modified over time, the exchange remained in effect for 45 years, until the lumber company ceased operation in 1954.

The following is Station "L" as described by R. H. Robley, in 1935:

> The powerhouse proper consisted of a boiler room 58 feet by 156 feet, and an engine room and generator room, 67 by 156 feet. Both were of reinforced concrete and brick with a thick curtain wall between the two main divisions of the plant. The (concrete) smokestack . . . is 12 feet in diameter and 120 feet high. The boiler installation was eight 400 HP boilers, designed for 200 pounds of pressure. The boilers were set in pairs, each pair being provided with a "dutch oven" furnace on one end . . . and the other end of each boiler fitted with a furnace design for oil burning.

Initially, hog fuel for the Station's furnaces was delivered "by electric motorcar on an elevated railway" from either the mill or the electric company storage house. In time, however, the fuel was transported by a system of conveyor belts directly from an enormous storage pile to the Station. This pile of wood waste became as much of a visual landmark on the east river bank as the Stephens House had been in the previous century. The supply of wood waste produced by Inman-Poulsen was also supplemented by material from other sources located up the river. It arrived on barges which were moored at the dock adjacent to the turbine room. However, because of economic and seasonal fluctuations in operations at the Inman-Poulsen Company, oil, following 1930, was used as a substitute fuel when necessary. Oil arrived either via the nearby railroad, or by barge from the Willamette River.

The electricity generated by Station "L" significantly increased the company's total output; in 1911 gross power production was 75% over 1908; and by the end of 1912 the increase was an additional 11-1/2%. However, because of competition from another company, the Northwestern Electric Company, additional generation facilities were not added until 1921.

Over the years the steam plant at Station "L" continued to increase in capacity. For instance, supplementary boilers and generators were attached to the older plant in 1924 to provide for a portion of this additional power. This boiler addition connected the original boiler room with Lincoln Substation.

PGE had been providing electricity for the city's streetcar lines since the early 1890s. For many years the bulk of the income of its parent company, Portland Railway, Light & Power Company, had come from providing electric power to the city's twenty-eight streetcar lines. In 1908, for example, the income produced from providing services to public transportation systems was three times the gross income rendered by the provision of electric power and light for other uses. After 1925, the rail lines' peak year for power consumption, the use of electricity began to shift to more non-transportation related uses. To fight this trend, the utility operated recreational parks outside the city limits; including the

Oaks Amusement Park, and the Vaughn Street baseball grounds. Travel was also promoted to nearby weekend vacation spots.

In the mid-1920s, the Portland Railway Light and Power Company underwent some internal reorganization. In April, 1924, the stockholders of PRL&P Company voted to change the company name to the Portland Electric Power Company (PEPCO). It was felt that the change in the company's name would more closely reflect the services it was now providing.

By 1929, the demand for additional power generation had again increased, and a new boiler and generator were added at Station "L". This necessitated the addition of a reinforced concrete building onto the north end of the 1910 turbine room. At the same time Stephens Substation was erected nearby to contain the control and switching equipment for the new generating unit.

During the Great Depression businesses gradually curtailed or ceased business operations and the demand for electrical energy decreased accordingly. The years 1931 through 1933 saw the greatest reduction in output, but by 1936, demand was once again on the increase. In the meantime PGE had inaugurated an aggressive campaign to promote the increased use of electricity by individual consumers because labor-saving home appliances such as ranges, refrigerators and water heaters, were becoming common necessities rather than rare luxuries.

In 1937, a new oil-fired boiler was put in place at Station "L". The boiler was one of the final pieces of equipment added to the complex primarily because in July, 1938, power from the Bonneville Power Authority became available for purchase. From this point forward PGE became more of a purchaser than producer of electric power and with the exception of the years between 1938 and 1942, growth and system requirements, until 1952, were accommodated through this purchasing deal. According to PGE historian, Arthur Greisser, "In 1943, annual power purchases exceeded net annual generation by the company's plants." As a result, this situation made it difficult for PGE to operate its smaller plants efficiently.

The period of shortages and rationing, which had been in effect during the years of the Depression and World War II, ended in 1946. By this time, additional federal hydroelectric projects had been completed or were underway. In comparison with the power it could purchase from the BPA, generating electricity at Station "L" became very costly for PGE. Additionally, the inexpensive hog fuel, which had been available from the Inman-Poulsen Company, now had a new increased value as a source of pulp for paper making. The neighboring mill itself had become a marginal operation with the depletion of old growth timber which had made it the "world's largest sawmill" in the first fifteen years of this century. As a result, in May, 1954, the company, its mill and timber holdings,

were sold to the Georgia-Pacific Company. The mill, which forty years earlier had operated twenty-four hours a day, closed shortly before the transaction. PGE purchased ten acres of the former mill property; in 1964 the Lone Star Cement Company acquired four acres for its plant, and numerous other businesses have their operations on the remaining twenty-one acres.

With the closure of the Inman-Poulsen Company and the absence of wood waste for fuel, the boilers at Station "L" were converted to utilize oil or natural gas in 1956-57. Although PGE purchased most of its power from BPA, demand for electricity was still greater than the amount BPA could supply. Coupled with seasonal requests for electricity in the winter months, the boilers at Station "L" were still occasionally called into service. However, late in 1964 the plant was reduced from its "spinning reserve basis" to "cold standby." During power shortages in 1973, Station "L" operated for approximately 60 days on natural gas. In December 1975, the generating equipment was retired and put up for sale.

This marked the end of Station "L"'s sixty-five year history of providing electricity to city residents. It had generated the power which ran the city's streetcar lines in the expansion-era years between the 1890s and the close of World War I. It had consistently provided heat, light and power to residential and business customers for almost seven decades. The number of buildings and amount of equipment had increased and improved as demand for electricity grew. Under the guidance of its skilled operators, and even during tumultuous periods of internal company reorganization, Station "L" always produced the power demanded of it. Of all of PGE's thermal generation plants, Station "L" was the one operated for the longest period of time. As such, it played a significant part in the growth and expansion of the city, as well as of the company which owned it.

PART III. STEAM-ELECTRIC GENERATION PROCESS, STATION "L"

Station "L" generated electricity through the steam-electric process. A steam-electric station is nothing more than a factory designed to change the form of matter to electricity. HAER No. OR-12-26 shows the general way in which a steam-electric station, such as Station "L", produces electricity.

In the first stage of this process, the potential chemical energy in a fuel, such as coal, oil, wood, etc., is released by combining the fuel with air inside of a burner. This process causes the two elements to burn and release thermal energy. A set of boiler tubes absorbs this energy (heat) and passes it on to water which is circulating within the tubes. Subsequently, the heat causes the water to boil and form steam. By letting the heated pressurized steam escape through a specially shaped nozzle, the heat-energy of the steam transforms into the kinetic energy of steam. A smooth jet of steam flows through the nozzle and exerts considerable force upon the blades or buckets of a turbine wheel. The strong force of the steam steadily turns the wheel. This process transforms the kinetic energy of steam into mechanical rotating-shaft energy. A shaft connected to the turbine wheel then turns a generator rotor, which consists of a magnet or field producing magnetic lines of force. In turn, these magnetic lines of force cut across a set of wire coils in the stator and to create an electrical current. At this point the energy takes on its final desired form: electricity. This is the steam electric process which occurred at Station "L".

Water Filters

Throughout its period of operation, Station "L"'s water supply was drawn from the Willamette River, which flows along the western edge of the power plant (HAER No. OR-12-27). The service water pumps delivered the river water to the Station at a total head approaching approximately 100 pounds per square inch (PPSI) with the help of six pumps ranging from 100 to 200 horsepower. The water was screened by an elaborate, self-cleaner mechanism before going into the boilers. These water filters were designed to remove suspended solids from the water within both the high and the low pressure steam systems of Station "L" (HAER No. OR-12-28).

The filters of this screening system consisted of two duplicate horizontal pressure filters of nominal size, six feet by eight feet, which were manufactured by the California Filter Company of San Francisco, California. According to the most conservative rating of the manufacturer, the maximum capacity of each unit was 96 U.S. gallons per minute; this is based on a filtering rate of 2 U.S. gallons per square foot of filter area. The total capacity of the water intake system in 1931 was 192 gallons per minute or 276,480 gallons in 24 hrs. However, this figure grew when the No.16 boiler was installed in 1937.

Besides providing water to the boilers, the intake system also provided water for oil cooling, bearing cooling, transformer cooling, cinder collection and conveying, the washing of traveling screens, hog fuel conveyor lubrication, fire protection, and the supply of water to the Inman-Poulsen saw mill.

Boilers

It was the function of the boilers, to heat the water, pressurize it and release steam into the turbines. By boiling water in a teapot until steam is forced out through the spout, one could recreate, on a simplified scale, the function of a boiler at Station "L".

Originally there were eight 440 HP boilers, manufactured by Babcock & Wilcox Co. (B&W Co.) of Barberton, OH and Bayonnet, NJ, located in the LP Boiler Room (Building L2) of Station "L" (HAER Nos. OR-12-29, OR-12-30). These boilers were fueled by "hog fuel" (saw dust) supplied to the plant by a neighboring saw mill, the Inman-Poulsen Mill, and other saw mills located up the river. The fuel coming from mills located up the river was transported to Station "L" in barges and then unloaded onto the stockpile by the Station's large clamshell "sawdust bucket".

The hog fuel was carried on conveyors from the storage pile, which was located on the south side of the Station, directly to the furnaces (HAER Nos. OR-12-31--OR-12-38). There were a number of these belt conveyors, some leading from the unloading docks to the stock pile and others leading from the stock pile to the furnaces, and each time a new boiler was installed, a new conveyor would be added to service it. This method of conveying fuel to the furnaces, however, did limit the volumetric measurement of fuel in the course of handling, so in order to determine the fuel consumption and efficiency of the boilers Station "L" would frequently test a carefully measured volume of fuel. This method was fairly satisfactory based on a month's performance but was somewhat questionable when taking the results from any one day's operation as an average because of the varying quality of hog fuel. In reference to fuel quality, there appears to have been a big difference between the quality of fuel when it was stored under cover as compared to outdoors. Outside storage gave better results than inside storage, especially if the fuel was stored upon a floor under which there was air space for circulation. As a result, Station "L" stored most of its fuel outside in a large pile. However, with the fuel stored in large piles the likelihood of internal fires increased. In the event of a sawdust fire, the plant had to first locate the fire and then dig into the pile at that location until they had literally "dug-out" the fire.

The furnaces of the original boilers were of the extended dutch oven, flat arched type, with a surface area of approximately 100 square feet. The fuel was fed to the furnaces by the conveying

system through two chutes located at the top of the furnace. When the hog fuel, as well a unconsumed carbon, was delivered through the chutes it entered a tapered combustion chamber within the furnace and was deposited onto a small section of grate bars located at the bottom of the chamber. Sufficient air was then admitted under these grates to consume the material. A pair of clean-out doors were located above and below the grates to provide means for cleaning the combustion chamber without taking the boiler out of service. Under normal firing conditions, the fuel bed consisted of two cones of fuel, each about five feet deep at the center and tapering to a feather edge along the front, while along the bridgewell the fuel bed banked up twelve to eighteen inches.

As of 1931, the furnaces were treated with the following: The No.1 furnace was treated with Johns-Manville cement; the Nos.2, 3, 5, 6, 7 and 8 furnaces were treated with Hychrome; the No.4 furnace was treated with special cement (name unknown); the No.9 furnace was untreated; the No.13 furnace was also treated with Hychrome and the No.14 furnace (the east wall) was treated with Latite on the east wall and treated with Calibax on the west wall.

Station "L"'s experience with hog fuel demonstrated that it was possible to obtain high ratings and good combustion if the fuel was agitated once it had been delivered into the furnace. In their experiments they used various combinations of forced draft, all with very poor results. Station "L" did not believe forced draft could be used to any advantage unless the moisture content of the fuel was practically zero. However, the induced draft application did lend itself readily to perfect control and as a result, in 1926, 290 HP draft fans were installed at Station "L" to increase the efficiency of the original eight boilers. All of the boilers which were added to the Plant had similar such devices.

A history of the growth and expansion of the boiler rooms as Station "L" increased its kilowatt output is as follows:

In 1920, the No.9 boiler was installed adjacent to the original eight boilers (Building L4, HAER No. OR-12-39). This boiler was a 500 HP Stirling Boiler manufactured by Babcock & Wilcox Co (B&W Co.). The eight 440 HP boilers had an estimated maximum rating for continuous operation of 250% and the 500 HP boiler had an estimated maximum rating for continuous operation of 300% while operating continuously with hog fuel. Given the high overload of these boilers required that an average of one boiler be out of commission for cleaning of grates, washing, and ordinary maintenance. Taking these factors into consideration, the maximum continuous rating of the Plant allowing for one boiler to be out of commission therefore became 9155 BHP, or its equivalent of 274,650 pounds of steam per hour.

As noted earlier, by 1926 the B&W Co. boilers of 440 HP capacity operated under induced draft. The gases of combustion were

discharged from each draft fan into a cinder cone, where the cinders were precipitated out and washed away. The original cinder-eliminating equipment for the Station's boilers consisted of fans which were about 75% efficient. These fans, however, became obsolete in 1922 when the first of the cinder eliminating cones were installed at Station "L". These cones were approximately 95% efficient. By 1926 the fans had been entirely replaced by the cones. Finally in 1927, Station "L" developed cinder washers for all of the high pressure boilers. The cinder washers were the latest in efficiency and practical operation. The cinder washers lent themselves to the further possible development of boiler economy in that heat exchangers could be used to conserve a large portion of the heat otherwise dissipated in the water used in the washing process. These washers were 99.7% efficient by 1930.

In 1923, three new boilers were added to the nine existing boilers, the No.10, 11 and 12 boilers (Building L4), and were all manufactured by the B&W Co. These boilers were installed to service the new 6,000 KW turbine which was also installed in 1923 and eventually the 12,500 KW unit which was installed in 1925. The No.10 and No.11 boilers were 440 HP boilers and the No.12 boiler was a 500 HP Stirling Boiler, all manufactured by B&W Co.

Station "L" first began the construction of boiler No.13 in 1925 and the boiler was first put into service on November 14, 1927 (HAER Nos. OR-12-31, OR-12-40--OR-12-43). This boiler (Building L4) was a 1669 HP Stirling Boiler, #8157, manufactured by the B&W Co. The unit was constructed to service a new 20,000 KW turbine unit. The boiler provided steam at a pressure of 275 pounds, heated the water to 700 degrees fahrenheit, and provided 166,246.5 pounds of steam per hour.

In 1930, Station "L" installed the No.14 boiler which was a 2650 HP Stirling Boiler #8528, manufactured by B&W Co. (HAER Nos. OR-12-44, OR-12-45). The boiler heated the water to approximately 600 degrees Fahrenheit, produced steam pressure of approximately 390 pounds per square inch, and supplied steam to the 35,000 KW unit. This boiler replaced the No.10, 11, and 12 boilers. It was at this time that the new HP Boiler Room was constructed (Building L4).

Finally, at 2:00 PM on August 28, 1937, Boiler No.16 was put on line at Station "L" (HAER No. OR-12-46). This boiler, manufactured by B&W Co., was installed to service the 6,000 KW turbine unit.

In 1930, the Station began using oil as an alternative fuel to hog fuel (HAER Nos. OR-12-47, OR-12-48). The larger boilers, Nos.13, 14 and 16, could operate on both oil and hog fuel as of 1930 and the original boilers, Nos.1-8, were converted to oil use in 1949. However, none of the boilers was completely dependent upon oil until the late 1950s. Instead, the Station alternated the use of oil and hog fuel on a regular basis.

Turbines

From the boilers the steam was then directed to the power house of the plant (Buildings L1 and L5) and into turbine generation units where it provided the energy to spin the turbine wheels; it was the spinning of these turbine wheels that produced the electrical current. The electricity created by the turbines was then conducted into the neighboring substations (Buildings L6 and L3). Once the steam had passed over the spinning turbine it entered a condenser located below the turbines where it would be cooled to liquid state. At this point, some of the water would be recycled back to the boilers and the rest would be returned to the river. A flow diagram of the steam generation process is shown in HAER No. OR-12-49.

The history of the growth and expansion of the engine room as Station "L" increased its kilowatt output is as follows:

In 1910 two 2,000 kw turbines occupied the plant. The No.1 and No.2 units were 11,000 volt, 1,800 RPM turbines manufactured by General Electric Co. of Schenectady, NY. A diagram depicting the general setup of these turbines may be seen in HAER No. OR-12-50. These turbines received steam at an average of 185 pounds gauge and at an average total temperature of 540 degrees fahrenheit. Station "L" operated both of these turbines beyond their suggested capacity. For instance, instead of using the suggested 165 pounds gauge of steam pressure on these turbines, the Station was using up to 210 pounds gauge. As a result, some of the nozzles cracked and the turbine shafts bent. By 1929, engineers suggested that these turbines, because of their condition, be removed from the plant; however, only one was removed.

All the turbines were shut down, overhauled, cleaned and repaired on an annual basis.

At this time, Lincoln Substation handled all of the power produced by the turbine units. Lincoln Substation continued to handle the entirety of the power produced by Station "L" (up to 40,500 KW) and the kilowatts produced by Station "M" (which was located on the upper Clackamas River and produced approximately 14,000 KW) until the 35,000 KW turbine unit was installed at Station "L" in 1930, at which time Stephen's Substation was constructed to handle the additional power produced by Station "L".

In 1923, the No.3 turbine was installed at Station "L". This new unit was a 6,000 KW turbine suitable for steam operation at 165 pounds gauge and at a total temperature of 600 degrees fahrenheit. The unit was originally powered by the No.10, 11, and 12 boilers but was switched, in 1937, to the No.16 boiler. This turbine was manufactured by General Electric Co. (HAER Nos. OR-12-51, OR-12-52).

In 1925, a 12,500 KW turbine was installed. This unit replaced one of the original 2,000 KW turbines as the No.1 unit. The 12,500 KW turbine operated at 1,800 RPM and was powered originally by the Nos.10, 11, and 12 boilers but was eventually switched to the eight LP boilers. This turbine was manufactured by General Electric Co. (HAER No. OR-12-52).

In 1926, a new 20,000 KW turbine was added to Station "L"', unit No.4 (HAER No. OR-12-53). This turbine was eight stages of steam expansion, 31,500 HP, 11,000 volts and designed for a maximum of 385 lbs of steam pressure at a temperature of 720 degrees fahrenheit. Steam was supplied to this turbine by the No.13 boiler. The size of this unit required the use of nine railroad cars simply to transport it to Station "L" for assembly.

In 1930, the No.6 unit, a 35,000 KW turbine manufactured by General Electric was added to Station "L" (HAER No. OR-12-54). This 1,800 RPM, fifteen stage unit was Station "L"'s final turbine installment and raised the Station's output to over 75,000 KW. The No.14 boiler supplied steam to this unit.

Condensate Units

Once the steam passed over the turbines it was directed into the condensing units which were located directly beneath the turbines (HAER No. OR-12-55). The 75 HP, 1,200 RPM, constant speed condensate pumps were manufactured by Westinghouse Electric & Mfg. Co. Once the steam again took the form of water, a majority of the water was released back into the river and a portion of the water was recirculated back into the system by a number of boiler feed pumps. These pumps operated under a static head of 41 feet and took on water at 230 degrees fahrenheit. Most of the motors used for driving these 500 HP, 1,800 RPM, variable speed boiler feed pumps were manufactured by General Electric Co.

As is apparent by the above description, the plant underwent a number of changes and expansions throughout its 65-year operation, such as additional turbines, building L5, additional boilers and building L8. The changes were all geared to increase the amount of electricity produced by the station; essentially the steam-electric process at Station "L" was the same in 1975 as it was in 1910, only it had increased its kilowatt production.

Station "L" provided power to the city's electric street railway, the adjacent southeast Portland residential/commercial district and handled part of the downtown load. As transmission facilities improved, the power was increased where needed. PGE operated a number of small thermal and hydro facilities and by World War II the bulk of the thermal generation was concentrated at Station "L". By the 1950s, the small hydro plants could not fill power demands and environmental, economic concerns precluded any additional installations. Instead, the large Bonneville Power Administration

surplus was utilized and as this ran out in the 1960s, the demand was fulfilled by the Boardman coal fired plant and the Trojan nuclear plant.

PART IV. PHYSICAL DESCRIPTION OF STATION "L"

Building L1

The Station "L" turbine room is a rectangular one-story brick and reinforced concrete building constructed in 1910. It shares its east wall with the adjacent boiler room (L2), built in the same year. It also shares its north wall with the powerhouse extension (L3), built in 1929.

The turbine room measures 70'x 160' with the long side parallel to the Willamette River. It is approximately 33' from the first floor to the bottom of the roof structure, which is a series of deep steel trusses with sloped-top chords spanning 54' east to west, 14' on center. A light monitor runs the full length of the building at mid-span. Steel channel purlins at 4'10-1/2" on center support corrugated asbestos cement roofing. This roofing, commonly known as Transite, is not original.

The building has a partial mezzanine on the west side and two basement levels. The lower basement slab is a mat foundation and the walls at both levels are cast-in-place concrete. The south exterior wall above grade, is of unreinforced brick masonry. The east wall, common to the boiler room (L2) is unreinforced brick masonry with embedded steel columns to carry roof and crane loads. The west exterior wall is a concrete frame with portions of the frame infilled with unreinforced brick masonry. A wooden catwalk and structural steel equipment deck are attached to the exterior of the west wall. The north wall was removed when the powerhouse extension was built in 1929.

Major equipment in the building includes an overhead crane, a large turbine generator at the south end of the building, electrical switch gear at the mezzanine and first floor levels, a small wooden control building and a maze of piping and miscellaneous equipment in the basement. The turbine room housed the large dynamos and generators which produced electricity from the steam generated in the boiler room (L2). There is a significant amount of miscellaneous structural steel framing supporting the various equipment. Structural reports find the building to be in good condition. Historically, the two original 2,000 KW units, the 6,000 KW unit, the 12,500 KW unit, and the 20,000 KW unit were located in this room.

Building L2

The Station "L" LP boiler room is a rectangular one-story brick and reinforced concrete building constructed in 1910. It shares its west wall with the adjacent turbine room (L1) built in the same year.

The boiler room measures 60'x 160' and is approximately 31-1/2' high from the first floor to the bottom of the roof structure. A light monitor runs the full length of the building at mid-span. It has trusses and purlins identical in configuration with those in the turbine room.

The building has one basement level. Like the turbine room, the walls are of cast-in-place concrete. The north and south exterior walls above grade are cast-in-place concrete to the bottom of the roof structure with unreinforced brick masonry above. The west wall, common to the turbine room (L1) is unreinforced masonry with embedded steel columns. The east exterior wall is a concrete frame, common to the HP boiler room (L3). Columns are laced steel, built up plate and channel tubes and rolled "H" beam sections. The floors of both the turbine and boiler rooms (L1, L2) are steel beams and joists with infill arched slabs between joists. Two major stacks, one masonry, one structural steel, penetrate the building at the west wall.

This room housed the eight original 440 HP boilers. Other major equipment in the building includes furnaces, various conveyors, major duct work and catwalks. Structurally, the boiler room is in fair condition. There is a substantial amount of asbestos lagging insulation throughout.

Building L3

The old Lincoln Substation (L3) is a square two-story cast-in-place concrete structure built in 1910-11, in conjunction with the construction of the LP boiler room and turbine room. It measures 40'x 65' and is approximately 40' tall. At the first floor, a mezzanine runs the full length of the west wall. The foundation system is not known, but condition of the building indicates it is probably supported on timber pilings. All walls, beams and slabs, including the flat roof structure are cast-in-place concrete. The building contained the high tension bus and switching equipment for buildings L1 and L2 and three transformers which received energy from Station "M" on the upper Clackamas River.

Major equipment in the building includes a series of concrete racks which formerly housed electrical equipment on both floors and electrical panels on the first floor. The building is in good condition, but stripped clean of all electrical equipment.

Building L4

The HP boiler room (L4) is a rectangular, one-story building with flat roof constructed of concrete and unreinforced brick. The boiler room was built in 1924 to house additional steam

generating equipment and is located between the LP boiler room on the west and the Lincoln Substation on the southeast.
The HP boiler room, which has a full basement, measures 80'x 135' and is approximately 25' high from first floor to the bottom of the roof structure. The basement slab is a mat foundation and walls are a combination of cast- in-place concrete and unreinforced brick masonry.

The south exterior wall above-grade is a concrete frame with unreinforced brick masonry infill. The top 10-15' of the wall is a light gauge steel frame with corrugated asbestos cement siding. The west wall adjacent to the LP boiler room is a light gauge steel frame with corrugated asbestos cement siding. The south one-third of the east wall is a concrete bearing wall, common to the old Lincoln Substation building. The remainder of the east and north walls are constructed of wood studs with corrugated metal siding. Columns are laced steel sections. There are few permanent floors in the building, and most of the floor structure is catwalks or timber planking for access to the boilers and other equipment. The south one-third of the roof, reconstructed in 1959, is constructed of structural steel trusses, open-web steel joists, steel roof deck. The balance of the roof structure is timber king-pin trusses, wood purlins and corrugated cement asbestos or metal roof deck. A light monitor runs the full length of the building at mid-span.

Major equipment in the building includes boilers No.13 and 14 and their conveyors, catwalks and other equipment necessary to services these boilers. Historically the No.9, 10, 11, and 12 boilers were also located on this site. The building is in very poor condition, according to structural reports. This building also contains much asbestos.

Building L5

The powerhouse extension (L5) is a flat-roofed one-story concrete building was constructed in 1929 to house a new 35,000 KW unit. It shares its south wall with the adjacent turbine room (L1).

The building measures 71'x 100' and 39' from the first floor to the bottom of the roof structure. It has two mezzanine levels on the west wall and two basement levels. The basement slab is a mat foundation designed to resist hydraulic uplift and to distribute load equally to the building's support piling. The building is constructed of cast-in-place concrete, except the roof structure, which is a series of deep structural steel trusses with sloped top chords spanning east to west, 17'9" on center. The steel purlins are 5'6-1/2" on center and the building has a concrete roof slab. All exterior walls are cast-in-place concrete. A light monitor with remote operated vent sash runs almost the full length of the building at mid-span. A concrete catwalk attached to the exterior

of the west wall connects with the adjacent dock just west and south of this building.

This building retains its original steel frame industrial-type windows. The west side of the building is divided into five bays; the north side into four bays. Each bay contains seven rows of windows, each divided only by a thin, narrow metal muntins. On the west side each window strip is divided into five panes of glass; on the north it is four panes. Each strip of windows could be opened to provide ventilation to the interior of the building. The concrete forms for the building were of boards and the interior surfaces are unfinished. The exterior walls were ground or sacked to a smooth finish. The form work was superior with well detailed inside and outside chamfers at corners. There are no visible voids or major patching in the interior walls. Structurally the building is in very good condition.

Building L6

This building is known as the Stephens Substation. Standing separate from the rest of Station "L", it is located east of the HP boiler room and old Lincoln Substation buildings. Built in 1929 of concrete, it is two stories in height and measures 50'x 60'. The Stephens Substation was erected to house the switching and control equipment for the 35,000 KW generating unit installed in 1930 (powerhouse extension L5) and also for a tie line between this substation and the old Lincoln Substation (L3).

Building L7

Building L7, constructed in 1940, is a one-story, 3850 square foot, wood framed storage structure with a metal exterior. The building is now used as a machine shop. The building is in poor condition.

Building L8

Building L8 houses boiler #16. Building L8 is wood framed and covered in metal. The building is in poor condition.

Structure L9

Related electrical equipment for Stephens Substation.

Building L10

This was a 500 square foot, one-story, wood- framed shop building with a metal exterior. The building was constructed c.1940s.

Other buildings on the site which did not participate in the steam generation process include:

Building A - PEPCO Building

The PEPCO Building, constructed in 1927, is a one story utilitarian type structure constructed of concrete. The building has a flat roof, industrial style windows, and metal scrolling doors. The structure has primarily open space within the interior for it is used for repairing cars, trucks, and other equipment. The major fixtures within the building are the hoists which are used for the repair work. Historically, this building has been used for maintenance and repair purposes.

Building B

This is a one-story, 1600 square foot storage building that has wood post-and-beam construction. It is approximately 55 years old and is in fair condition.

Building C

This is a one-story, metal engineered building with corrugated metal walls and roof. The building has a mezzanine storage area. The structure consists of 4500 square feet, is approximately 10 years old, and is utilized as an office and a garage.

Building D

This is a 200 square foot, one-story building with a microwave tower above. It was constructed c.1955 and is in fair condition

Building E

This is a 1600 square foot, one-story, wood frame building constructed c.1950s.

Building F

This is a 2750 square foot, one story, wood framed building with corrugated metal walls and roof. It was constructed in the 1940s and was utilized for welding and storage.

Building G - Office Building

The office is a small one-story, 800 square foot wood-framed structure with a gabled tin roof, two rooms and a bathroom. Within this building, Station "L" stored most of its activity records and construction plans. This building was constructed c.1930.

Buildings J and K

These are two very small structures each with less than 200 square feet in area.

NOTE: See HAER Nos. OR-12-56 and OR-12-57 for reference drawings

BIBLIOGRAPHY

Oregonian - 7/28/1869
10/26/1869
10/29/1869
9/5/1870
5/29/1879
6/8/1892
6/21/1892
11/27/1896
11/28/1896
12/8/1910
1/17/1918
4/28/1920
10/30/1929
6/30/1935
3/26/1938
4/10/1946
4/11/1946
5/27/1954

Journal - 5/15/1915
4/27/1920
6/24/1924
10/29/1929
1/14/1929
3/29/1939
5/30/1954
8/28/1965

Portland Evening Telegram - 2/18/1916
10/22/1921
10/30/1929

City of Portland Directories, 1890-1950

Sanborn Fire Insurance Maps, 1909-1955

Conversation with Harry E. Randall, PGE employee, Station "L", February 1985.

MacColl, E. Kimbark, The Shaping of a City, Business & Politics in Portland, Oregon 1885-1915. Portland, Oregon, The Georgian Press, 1976.

_____, The Growth of a City, Power & Politics in Portland, Oregon, 1915 to 1950. Portland, Oregon, The Georgian Press, 1979.

Robley, Roy R., Portland Electric Power Co., With its Predecessors and Subsidiary Companies, 12/16/1860-12/31/1935. Portland, Oregon, The PGE Co., 1935.

Greisser, Arthur H., Portland General Electric Company - History, 1889-1981. Portland, Oregon, PGE, 1982.

_____, History of the Columbia River Valley, Vol. III. Chicago, S. J. Clarke Publishing Co., 1828.

Skrotzki, Bernhardt, Electric Generation--Steam Stations. New York, New York, McGraw-Hill, 1956.